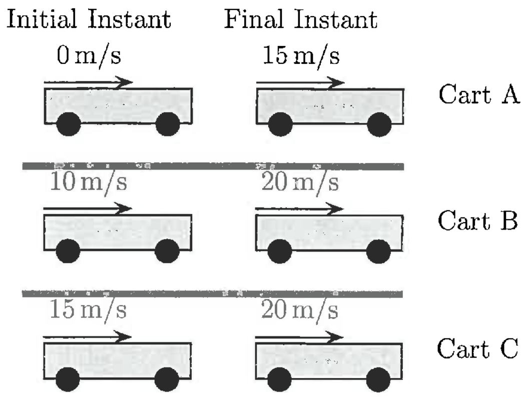
~~2015~~ 2016

~~14~~ 29 **Moving carts**

Three identical carts move horizontally along tracks. Their speeds at two instants 5.0 s apart are indicated. Let $F_A$ be the magnitude of the force acting on A during this interval, $F_B$ be the magnitude of the force acting on B, etc, .... Which of the following is true? Explain your answer.




i) $F_A > F_B > F_C$.

ii) $F_B = F_C > F_A$.

iii) $F_B = F_C < F_A$.

iv) $F_A = F_B = F_C \neq 0$

$F = ma$

The masses are same so acceleration is what matters

Cart A $\quad a = \frac{\Delta v}{\Delta t} = \frac{15 m/s}{5 s} = 3 m/s^2$

B: $\quad a = \frac{10 m/s}{5 s} = 2 m/s^2$

C: $\quad a = \frac{5 m/s}{5 s} = 1 m/s$

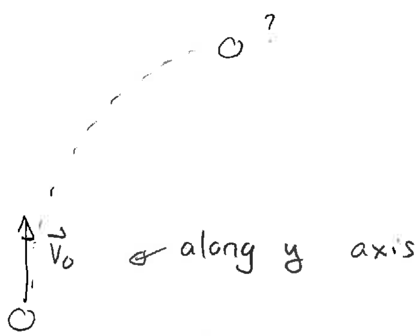
$\Rightarrow \quad F_A > F_B > F_C$

a) $\vec{F}_{net} = m\vec{a}$

$8.0N\,\hat{i} = 2.0kg\,\vec{a} \quad \Rightarrow \quad \vec{a} = 4.0m/s^2\,\hat{i}$

$\Rightarrow \quad a_x = 4.0m/s^2$

$a_y = 0m/s^2$




Then

| | |
|---|---|
| $t_0 = 0s$ | $t_1 = 4s$ |
| $x_0 = 1.0m$ | $x_1 =$ |
| $y_0 = 0.0m$ | $y_1 =$ |
| $v_{0x} = 0m/s$ | $v_{1x} =$ |
| $v_{0y} = 5.0m/s$ | $v_{1y} =$ |

Now $\quad x_1 = x_0 + v_{0x}\Delta t + \frac{1}{2}a_x(\Delta t)^2$

$= 1.0m + 0m/s \times 4.0s + \frac{1}{2}(4.0m/s^2)(4.0s)^2 \Rightarrow \boxed{x_1 = 33m}$

$y_1 = y_0 + v_{0y}\Delta t + \frac{1}{2}a_y(\Delta t)^2$

$= 0.0m + 5.0m/s \times 4.0m/s + \frac{1}{2}(0m/s^2)(4.0s)^2 \Rightarrow \boxed{y_1 = 20m}$

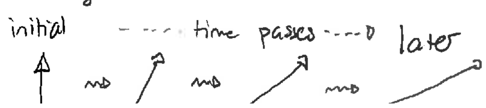
Position.

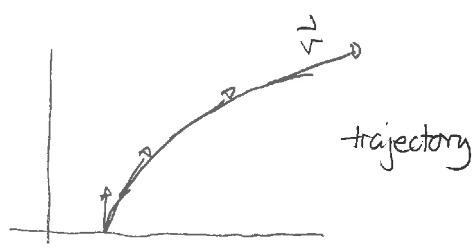
Then $\quad v_{1x} = v_{0x} + a_x\Delta t \quad = 0m/s + (4.0m/s^2) \times (4.0s) \Rightarrow \boxed{v_{1x} = 16m/s}$

$v_{1y} = v_{0y} + a_y\Delta t \quad = 5.0m/s + (0m/s^2) \times (4.0s) \Rightarrow \boxed{v_{1y} = 5m/s}$

Velocity

b) Constant $v_x$ increasing $v_y$ means velocity vector changes as



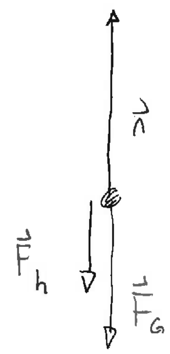



Knight Ch6

Conc Q 12

For the book. Then

$$\vec{F}_{net} = \sum \vec{F} = m\vec{a}$$




but $\vec{a} = 0$ and

$$\sum \vec{F} = 0$$

$$\Rightarrow \quad n - F_{hand} - F_G = 0$$

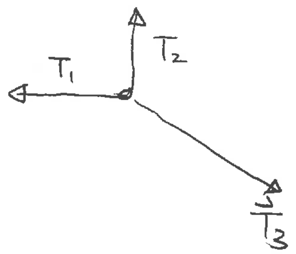
$$\Rightarrow \quad n = F_{hand} + \underbrace{F_G}_{mg}$$

So $n$ larger than $mg$

Knight Ch6

$4^{ed}$ Prob 1

Equilibrium $\Rightarrow$ $\vec{F}_{net} = 0$




$\Rightarrow$ $\sum F_{ix} = 0$

$\sum F_{iy} = 0$

Get components of forces
then

| | x | y |
|---|---|---|
| $\vec{T}_1$ | $-50N$ | $0N$ |
| $\vec{T}_2$ | $0N$ | $80N$ |
| $T_3$ | ? | ? |

$T_{1x} + T_{2x} + T_{3x} = 0$

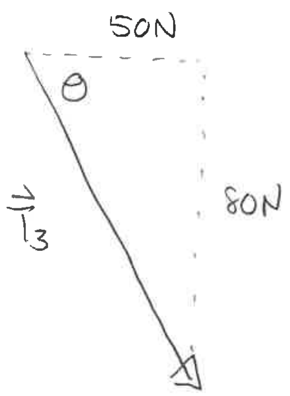
$T_{1y} + T_{2y} + T_{3y} = 0$

$\rightarrow$ gives $-50N + 0N + T_{3x} = 0$

$\Rightarrow$ $T_{3x} = 50N$

$\rightarrow$ $0N + 80N + T_{3y} = 0$ $\Rightarrow$ $T_{3y} = -80N$

Draw $\vec{T}_3$




$T_3 = \sqrt{T_{3x}^2 + T_{3y}^2}$

$= \sqrt{(50N)^2 + (-80N)^2} = \boxed{94N = T_3}$

the angle $\theta$ satisfies

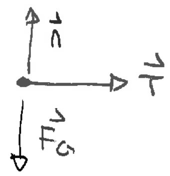
$\tan\theta = \frac{80N}{50N} = \frac{8}{5}$

$\Rightarrow \theta = \tan^{-1}(8/5) = 58^\circ$

Knight Ch 6

$4^{ed}$ Prob 12

a) $\vec{F}_{net} = 0$




$F_{net\,x} = 0 \Rightarrow T = 0$

b) $\vec{a} = 0 \Rightarrow \vec{F}_{net} = 0 \Rightarrow F_{net\,x} = 0 \Rightarrow T = 0$

c) $\vec{a} = 5.0\,m/s^2\,\hat{i} \Rightarrow a_x = 5.0\,m/s^2$

$\Rightarrow F_{net\,x} = ma_x$

$\Rightarrow T = ma_x = 50kg \times 5.0\,m/s^2$

$= 250N$

Knight Ch6

4ed Prob 15


$t_0 =$      $t_1 = 20s$      $t_2 = ??$,

$x_0 =$    $a_x =$    $x_1 = 0m$    $a_x = 0m/s^2$    $x_2 = 12000m$

$v_0 =$      $v_1 = ?$      $v_2 = ?$

Need $v_1$. Use $v_1 = v_0 + a\Delta t$

$$v_1 = 0m/s + a\,20s \Rightarrow v_1 = a\,20s.$$

But $\vec{F}_{net} = m\vec{a} \Rightarrow 1200\times10^3 N = 8.0\times10^9 kg\ a$

$$\Rightarrow \frac{1.2\times10^6 N}{8.0\times10^9 kg} = a \Rightarrow a = 15m/s^2.$$

So $v_1 = 15m/s^2 \times 20s = 300m/s$.

Now for the coasting period

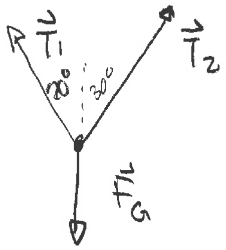
$$x_2 = x_1 + v_1\Delta t + \cancel{\tfrac{1}{2}a(\Delta t)^2}$$

$$12000m = 0m + 300m/s\ \Delta t \Rightarrow \Delta t = 40s$$

Knight Ch 6

$4^{ed}$ Prob 39

FBD




m=1000 kg

$$\vec{F}_{net} = m\vec{a} = 0 \quad \text{since } \vec{a} = 0$$

$$\vec{F}_G + \vec{T}_1 + \vec{T}_2 = 0$$

$$\sum F_x = 0 \qquad F_{Gx} = 0$$

$$\sum F_y = 0 \qquad F_{Gy} = -mg$$

$$T_{1x} = -T_1 \sin 20^\circ \qquad T_{2x} = T_2 \sin 30^\circ$$

$$T_{1y} = +T_1 \cos 20^\circ \qquad T_{2y} = T_2 \cos 30^\circ$$

$$\sum F_x = 0 \Rightarrow -T_1 \sin 20^\circ + T_2 \sin 30^\circ = 0 \Rightarrow T_2 = T_1 \frac{\sin 20^\circ}{\sin 30^\circ} = 0.68\, T_1$$

$$\sum F_y = 0 \Rightarrow -mg + T_1 \cos 20^\circ + T_2 \cos 30^\circ = 0$$

$$\Rightarrow T_1 \cos 20^\circ + 0.68\, T_1 \cos 30^\circ = mg$$

$$\Rightarrow T_1 (\cos 20^\circ + 0.68 \cos 30^\circ) = mg$$

$$\Rightarrow T_1\, 1.53 = 1000\,kg \times 9.8\,m/s^2 \Rightarrow T_1 = 6.4\times10^3\,N$$

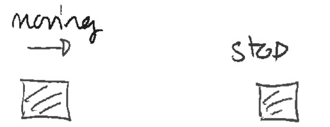
Then $T_2 = 0.68\, T_1 = 4.3\times10^3\,N$

Knight Ch 6

4ed Prob 42

a) $\vec{F}_{net} = m\vec{a} \Rightarrow F_{bag} = ma$

need acceleration




$t_0 =$ $\quad$ $t_1 =$

$X_0 = 0$ $\quad$ $X_1 = 1.0m$

$V_0 = 15m/s$ $\quad$ $V_1 = 0m/s$

$V_1^2 = V_0^2 + 2a\,\Delta x \Rightarrow (0m/s)^2 = (15m/s)^2 + 2a \times 1.0m$

$\Rightarrow -225m^2/s^2 = 2.0m\,a$

$\Rightarrow a = -113m/s^2$

So $F = ma \Rightarrow F = 6.8\times10^3 N$

b) Same method but $\Delta x = 0.005m$

$\Rightarrow V_1^2 = V_0^2 + 2a\,\Delta x \Rightarrow 0m^2/s^2 = 225m^2/s^2 + 0.01m\,a$

$\Rightarrow a = -22500m/s^2$

So $F = ma \Rightarrow F = 60kg \times 22500m/s^2$

$= 1.4\times10^6 N$